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I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PS 3194 for a patent by THORLOCK INTERNATIONAL LIMITED as filed on 24 June 2002.

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Seventh day of July 2003

J. Billingsley

JULIE BILLINGSLEY
TEAM LEADER EXAMINATION
SUPPORT AND SALES

P/00/009 28/5/91
Regulation 3.2

ORIGINAL

AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Invention Title:	Monitoring Probes for Nuclear Quadrupole Resonance Measurements (#12)

The invention is described in the following statement:

"Monitoring Probes for Nuclear Quadrupole Resonance Measurements"

Field of the Invention

This invention relates to, but is not limited to, the detection of explosives and narcotics located within mail, airport luggage and other packages using nuclear quadrupole resonance (NQR). More specifically it relates to overcoming the drift in NQR frequency with temperature, detection of RF noise and metal objects before scanning for NQR substances and determination of the scan object's dimensions.

Throughout the specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Background Art

The following discussion of the background art is intended to facilitate an understanding of the present invention only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to is or was part of the common general knowledge in Australia as at the priority date of the application.

NQR has been proposed as an alternative technology for the detection of explosives, narcotics and other illicit substances. Whilst NQR detection technology in theory may be used to detect explosives in items at airports, mail centres and entry points to important buildings such as courthouses etc, in practice, great difficulty has been encountered in designing and producing an NQR scanner that is practicable and reliable to operate in such environments.

An NQR scanner device theoretically brings an item to be scanned, such as luggage, to stop within a coil or near a coil or coils. The computer in control of the device directs the transmitter to irradiate the item being scanned with a burst of radiofrequency (RF) waves which excite an NQR substance within the item being

scanned. After a short period of dead time the receiver detects any very small voltage induced on the coil by relaxing quadrupolar nuclei. The computer then receives and transforms this signal and determines whether this signal exceeds a predetermined threshold level. If the signal does exceed the threshold level an alarm is signalled to the operator.

It has been found, however, that the entire process is dependent upon the physical characteristics of the item being scanned and the surrounding environment. Certain characteristics of the scan item affect the detection capability and the false alarm rate.

One of the major problems that has so far restricted the use of NQR technology is the fact that the NQR frequencies drift with temperature. The amount NQR frequencies drift is not large (427Hz/°C for the 5.2MHz line of RDX), but enough to cause problems in measuring small hard to find signals as would be required in a practical NQR scanner. The main problem is that if the temperature of the item is unknown, then the resonant frequency of the NQR substance will also be unknown. The item may be irradiated at the incorrect frequency resulting in a missed detection.

To overcome this problem the range of frequencies irradiated can be enlarged by using a lower transmit Q factor, however this would still result in a possible missed detection because a high Q factor receive is usually required to detect such small NQR signals.

An alternative method is to selectively irradiate small sections of the frequency spectrum sequentially so the probability of detection increases. By using this method a range of frequencies corresponding to a range of temperatures can be irradiated maximising the probability of detection. For instance, in an airport scenario, it may be expected that the range of temperatures encountered may be 0-40°C, hence by arranging the system to irradiate all frequencies that correspond to that temperature range, the explosive should be detected.

One of the problems with the above method is the fact that it requires the use of sequential pulse sequences, each of which consume valuable time. During airport scanning of baggage, the time allowed for scanning a bag approximately ranges from 6-20 seconds. By scanning a range of temperature of 10-35°C, as many as 3 or 4 pulse sequences have to be applied so that the explosive is properly irradiated. This method results in an unacceptably long delay which frustrates the machine operator and passengers alike.

Furthermore, when irradiating the bag with two separate pulse sequences, there is a strong possibility that the explosive will be partially excited on the first sequence, resulting in a weak signal which is not detected, and then partially excited again on the second sequence, which is also not detected, resulting in a missed detection.

It is possible to interleave the pulse sequences such that each successive pulse group has one of the 3 or 4 frequencies required. However, the time taken to achieve the same signal sensitivity is still 3 or 4 times longer as compared to a single pulse sequence.

In the process of scanning objects and relying upon RF frequencies for signal detection, NQR scanners invariably encounter the problem of interference. The interference can be external or internal to the machine. One form of internal interference can emanate from the item being scanned. Items such as mobile phones, toys, video cameras, watches etc all emit RF noise resulting in difficulty in the detection of weak NQR RF signals. To overcome this pulse sequences have been invented which partially counteract this problem.

A further problem is that detection of objects encased within metal by NQR is difficult. The RF generated by an NQR scanner device is generally unable to penetrate metal surfaces due to the eddy current effect.

Disclosure of the Invention

It is an object of the present invention to improve the detection of NQR within scanned packages, such as airport luggage.

It is one preferred object of the invention to provide for the improvement in such detection of NQR by having regard to the temperature effect problem.

According to a first aspect of the present invention, this preferred object is achieved by using one or more temperature probes in conjunction with an NQR scanner. These probes either sense the ambient temperature or the scan item temperature to determine at which frequency the sample should be irradiated.

In accordance with the first aspect of the present invention there is provided a temperature probe which is added to an NQR device that is able to detect the temperature and then direct the NQR device to irradiate the sample within the device at a range of NQR frequencies which lie close to the NQR frequency which corresponds the temperature measured.

Preferably, the detected temperature is the ambient room temperature.

Preferably, the detected temperature is the external building temperature.

Preferably, the detected temperature is the scan item external temperature.

Preferably, the detected temperature is the scan item internal temperature.

Preferably, the detected temperature is some combination of the ambient room temperature, the external building temperature, the external item temperature & internal item temperature.

Preferably, a thermal image of the item is used to determine its temperature and detect excessively hot or cold scan items.

Preferably, the temperature detected originates from a probe ('tag') attached to the bag.

Preferably an RF probe is used to monitor any RF emissions from the item to be scanned prior to it being scanned.

Preferably sensors are used to determine the height and length of a scanned item prior to it being scanned.

It is another preferred object of the present invention to provide for the improvement in such detection of NQR by overcoming or at least mitigating the problem of interference.

According to a second aspect of the present invention, this preferred object is achieved by using a probe which monitors the RF emissions from the object to be scanned before it is scanned. This probe is used to sense if the RF emissions exceed a prescribed threshold and if so, indicate that the scan item is not appropriate for NQR detection.

In accordance with the second aspect of the invention, there is provided a probe which is added to an NQR device that is able to detect RF emissions from a sample and send signals representative thereof to the NQR device, the NQR device having processing means to monitor the signals and if the RF emissions from an item containing a sample exceed a prescribed threshold level, a signal is provided indicating that the item is not appropriate for NQR detection.

It is another preferred object of this invention to provide for the improvement in such detection of NQR by the detection of metal objects contained within objects to be scanned.

In accordance with a third aspect of the present invention, this preferred object is achieved by an RF antenna that is excited with pulses of RF energy and which irradiates an item to be scanned. This RF antenna allows a return signal to be

measured and transformed into frequency space after a period of dead time to indicate whether there is a significant amount of metal present.

In accordance with the third aspect of the invention, there is provided an RF antenna that is attached to an NQR device so that the antenna may be excited with pulses of RF energy that is able to irradiate a sample and receive return signals after a period of dead time, the NQR device having processing means to measure and transform the return signals into frequency space, and if the signal detected at the transmit frequency exceeds a predetermined threshold, signal the presence of a significant amount of metal.

Brief Description of the Drawings

The invention will be better understood in the light of the following description of several specific embodiments thereof. The description is made with reference to the accompanying drawings, wherein:

Fig.1: shows a block diagram of an NQR scanner device in accordance the various embodiments;

Fig.2: is a schematic plan view of the NQR scanner device of Fig 1;

Fig.3 is a flowchart of the decision process for detection of RF noise emanating from the scan item;

Fig.4: is a flowchart of the decision process for the embodiment of the pulse induction detection of metal objects within a scan item, in accordance with the first embodiment fo the best mode for carrying out the invention;

Fig.5: is a flowchart of the decision process for the alternative embodiment of the induction balance detection of metal objects within a scan item, also in accordance with the first embodment of the best mode;

Fig.6: is a flowchart of the decision process for the embodiment of the pulse induction metal imaging of metal objects within a scan item, in accordance with the best mode; and

Fig.7: is a flowchart of the decision process for induction balance metal detection of metal objects within a scan item.

Best Mode(s) for Carrying Out the Invention

The best mode for carrying out the invention will now be described with reference to an NQR scanner device the main components of various embodiments of which are shown in block diagram form in Figure 1 of the drawings.

As previously mentioned, one of the problems associated with using the prior art method of scanning a nuclear quadrupole substance with multiple pulse sequences at differing transmit frequencies to cover a large temperature range is that this causes a large time delay.

This process can be performed more efficiently by sensing the ambient temperature and irradiating the item to be scanned with a range of frequencies close to the NQR frequency which corresponds to the temperature measured. Thus one of the features of the best mode for carrying out the invention is that the scanner device only needs to transmit one pulse sequence at one frequency and thus saves valuable time, which leads to an increased throughput for the NQR scanner machine.

Referring to Figures 1 and 2, one or more temperature probes 13, RF antennas 17, metal detectors 18, metal imagers 19, temperature tags 20 and optical or infrared scanners 22 and 23, or any one or combination of these are electrically attached either directly or wirelessly to an NQR scanner device 16 that generally comprises a transmitter unit 10, a receiver unit 11, a computer 12 and a coil 15.

The NQR device 16 scans airport luggage, postal items etc. searching for illicit substances.

The first embodiment of the invention is directed towards an NQR scanner device 16, where the temperature probe or probes 13 sense the ambient room temperature prior to scanning an item 14 of interest, and then the NQR device scans the item.

The range of frequencies at which the NQR device 16 scans the item 14 lies close to the frequency which mathematically corresponds to the temperature or temperatures measured by the probe or probes 13. If multiple probes 13 are used then some mathematical combination is used to calculate the best temperature, such as the average. The computer 12 takes the temperature measured by the probe or probes 13 and computes the corresponding frequency via a look up table or direct calculation. For instance, the RDX 5.2MHz NQR line drifts approximately at a rate of 427.4Hz/°C close to room temperature. Hence after measuring the temperature this number is input into the following equation:

$$\text{Frequency} = 0.4274 \times \text{Temperature} + 5202\ ; \qquad (1)$$

where: Temperature is in °C and the Frequency is in kHz.

Equation 1 produces a frequency at which to scan the item. The computer 12 directs the transmitter 10 to send pulses to the coil 15 which irradiates the sample at a range of frequencies close to this value.

Pulses at these frequencies excite the NQR substance within the item creating a small RF magnetic field which induces a small voltage on the coil 15 that is measured by the receiver 11 and sent to the computer 12, resulting in a detection. This detection is accomplished at a much faster rate as compared to the prior art method of irradiating the substances with 3 or 4 pulse sequences at different frequencies to cover a large temperature range.

One or more RF antennas 17 are attached to the NQR scanner 16. As an example, these antennas could be narrow single turn coils of the same external dimension as the opening of the NQR scanner, and which are resonant at the NQR frequencies. These coils do not transmit any signal but are arranged to only receive signals. These antennas monitor the RF emissions emanating from the item 14 to be scanned. After being received on the single turn coil the signals are amplified and sent to the computer 12 via an analogue to digital converter (ADC). On the computer 12 the signals are filtered and then fourier transformed to determine if there are any significant frequency peaks lying near to the NQR frequency of interest. If significant frequency peaks are found to exist above a predescribed threshold value, then a signal is produced indicating that the item is not suitable for NQR detection. Accordingly, the item is not scanned and it passes straight through the NQR system to be possibly hand searched. If no significant frequency peaks are found then the item is moved into the scan volume and scanned. The decision making process is shown in Fig.3.

One or more RF antennas belonging to a metal detector 18 are also attached to the NQR scanner 16 so that these antennas may be excited with pulses of RF energy which is irradiated into the scan item 14. These antennae could be single turn coils having substantially the same dimensions of the coil within the NQR scanner 16. The transmission of the RF energy signals induces eddy currents within metallic objects within the device, if any such objects are present. After a suitable period of dead time to allow for ring down of the coil, the eddy currents within the metal objects induce a signal upon the coil. This signal is amplified and converted into a digital signal via an ADC. This digital signal is then fed to a computer where it is filtered and fourier transformed into frequency space. If significant peaks exist above a predescribed threshold level and close to the transmission frequency in the frequency spectrum, then the scan item 14 is flagged as having siginificant amounts of metal. An alarm or visual display is then signalled indicating the presence of a significant amount of metal to the operator. Fig.4 shows a flow chart of the decision making process.

In an alternative embodiment of the metal detector 18, two or more RF antennas of the metal detector 18 are attached to the NQR scanner 16 so that at least one

of these antennas or coils are excited with continuous RF energy which is irradiated into the scan item 14. Two or more coils are required because these coils are in induction balance. That is, at least one coil transmits a signal and the remaining coils receive this signal but null it out either by suitable arrangement of the coils, or by applying a counteracting nulling signal to the receiving coils. These antennae could be single turn coils having substantially the same dimensions of the coil within the NQR scanner 16. The introduction of metal objects near to the coil disturbs the induction balance and results in a change in current required to maintain induction balance or simply a current is drawn through the receiving coil or coils. This current is converted into a digital signal via an ADC and then sent to a computer 12. If this current lies bove a predescribed threshold level, then the scan item 14 is flagged as having siginificant amounts of metal. An alarm or visual display is then signalled indicating the presence of a significant amount of metal to the operator. The decision making process is shown in Fig.5.

One or more metal imagers 19, capable of creating an image of the metal objects within the scan item 14, are also attached to the NQR scanner 16. To create an image of metallic items within the scan item, multiple coils are used. These multiple coils are arranged in a planar 2D or box shaped 3D array. In the 3D array, the coils are placed onto the sides of a hollow rectangular box such that the scan item can be passed through the box and thus be imaged in 3D by the array. Each coil of the array is subjected to a transmit pulse which excites metal objects within the scan item and induces eddy currents. After a period of dead time, to allow for the coil ringing to subside, the eddy currents within the metal objects induce signals on the coil array. These signals are amplified and individually sent to an ADC where they are converted into digital signals. These signals are sent to the computer where they are fourier transformed into frequency space. The resulting frequency signals for each coil are represented by the size of the frequency peak and these peak intensities are combined to form a 2D or 3D metal image of the object. By appropriately scaling any image formed to real physical dimensions, it is possible to calculate what area or volume the image occupies. If the area or volume occupied by a metal object exceeds a threshold value then the

item is flagged as being possibly suspicious and sent to be hand searched or resolved by an X-ray scanner. The decision making process is shown in Fig.6.

In an alternative embodiment of the metal imagers, one or more metal imagers 19, capable of creating an image of the metal objects within the scan item 14, are similarly attached to the NQR scanner 16. However, in order to create an image of metallic items within the scan item 14 in this particular embodiment, multiple coils are used and the receiving coils of this system are in induction balance. These multiple coils are arranged in a planar 2D or box shaped 3D array as before, whereby in the 3D array, the coils are placed onto the sides of a hollow rectangular box such that the scan item can be passed through the box and thus be imaged in 3D by the array. However in this arrangement, at least one coil is used to excite the system and the other coils are used to form the image. These other coils are in induction balance and do not receive the transmitted signal, either because they are suitably arranged, or a counteracting current is applied to the receiving coils to keep them in a null state. The transmitting coil of the array is subjected to a continuous RF signal. If a metal object comes close to the metal array the induction balance is broken and currents will flow through the receiving array of coils. These currents are converted individually into a digital signal via an ADC and sent to the computer. The computer takes these individual currents and combines them to form a 2D or 3D metal image of the object. By appropriately scaling any image formed to real physical dimensions of the scan item 14, it is possible to calculate what area or volume the image occupies. As before, if the area or volume occupied by a metal object exceeds a threshold value, then the scan item 14 is flagged as being possibly suspicious and sent to be hand searched or resolved by an X-ray scanner. The decision making process is shown in Fig.7.

As shown in Figure 2, one or more lines of optical or infrared scanners 22, 23 are positioned along a scanning conveyor 25 such that the length and height of the scan item 24 can be determined prior to scanning. The sensors are positioned in straight vertical lines 23 to determine the height of the scan item 24 and straight horizontal lines 22 to determine the length of the scan item. If the scan item 24 exceeds the required height for the NQR screening area 21, then it is bypassed

around the scanning area 21 and not scanned. If the scan item's length is too long, then it is either bypassed around the scanning area 21 or it is scanned in two successive scans. The first scan covers approximately one half of the scan item & the second scan covers approximately the second half of the scan item. The results from the two scans are either analysed separately or added together to determine if an NQR substance is present or not.

The second embodiment of the best mode is substantially identical to the first embodiment, except that in the second embodiment, an external temperature probe or probes 13 are connected to the NQR scanner which sense the external building temperature. Signals representative of the external building temperature are in turn sent to the computer 12, which then instructs the transmitter unit 10 to send pulses to the coil 15 irradiating the scan item 14.

As in the first embodiment, if multiple probes are used then some mathematical combination is used to calculate the best temperature, such as the average. Temperatures are converted to frequencies via equations, such as equation 1, for each separate substance. The scan item is irradiated at a range of frequencies close to the frequency produced by conversion of the temperature to a frequency. Pulses at these frequencies excite the NQR substance within the item creating a small RF magnetic field that induces a small voltage on the coil 15 which is measured by the receiver 11 and sent to the computer 12, resulting in a detection.

The external building temperature is measured in this embodiment because the NQR scanner may serve as an entry point to an important building such as a courthouse etc. Hence items brought into the building probably will reflect the external building temperature rather than the internal room temperature.

The third embodiment of the best mode is substantially identical to the first and second embodiments, except that in the third embodiment the temperature probe or probes 13 on the NQR scanner sense the external item temperature. Signals representative of the external item temperature are sent to the computer 12. The computer 12 then instructs the transmitter 10 to send pulses to the coil 15 irradiating the scan item 14 at a range of frequencies which lie close to the

frequency calculated from the measured temperature. If multiple probes are used then some mathematical combination is used to calculate the best temperature, such as the average. Temperatures are converted to frequencies via equations, such as equation 1, for each separate substance. Pulses at these frequencies excite the NQR substance within the item creating a small RF magnetic field that induces a small voltage on the coil 15 which is measured by the receiver 11 and sent to the computer 12, resulting in a detection.

The external item temperature is measured in this embodiment because it may be found that the temperature of the scan item 14 is the most representative temperature of the substance being scanned.

The fourth embodiment of the best mode is substantially identical to the preceding embodiments, except that in the fourth embodiment, the temperature probe or probes 13 on the NQR scanner sense the internal item temperature. Signals representative of the internal item temperature are sent to the computer 12. The computer 12 instructs the transmitter 10 to send pulses to the coil 15 which irradiates the scan item 14 at a range of frequencies which lie close to the frequency calculated from the measured temperature. If multiple probes are used then some mathematical combination is used to calculate the best temperature, such as the average. Temperatures are converted to frequencies via equations, such as equation 1, for each separate substance. Pulses at these frequencies excite the NQR substance within the item creating a small RF magnetic field that induces a small voltage on the coil 15 which is measured by the receiver 11 and sent to the computer 12, resulting in a detection.

The internal bag temperature is measured in this embodiment because it may be found that the bag temperature is the most representative temperature of the substance being scanned.

The fifith embodiment of the best mode is substantially identical to the preceding embodiments, except that in the fifth embodiment, temperature probe or probes 13 attached to the NQR scanner sense one or more of room temperature, external building temperature, external item temperature or internal item

temperature. Signals representative of these results are sent to the computer 12 which then instructs the transmitter 10 to send pulses to the coil 15 which irradiates the scan item 14 at a range of frequencies which lie close to the frequency calculated from some combination of the measured temperature or temperatures. The temperature is converted to a frequency via equations such as equation 1 for each separate substance. Pulses at these frequencies excite the NQR substance within the item creating a small RF magnetic field that induces a small voltage on the coil 15 which is measured by the receiver 11 and sent to the computer 12, resulting in a detection.

In this embodiment it may be found that the best temperature to scan the bag is some mathematical combination of one or more of the temperatures being measured.

The sixth embodiment of the best mode is substantially identical to the preceding embodiments, except that in the sixth embodiment a temperature sensor or sensors 13 attached to the NQR scanner creates a thermal image or images of the item to be scanned. Signals representative of this image or images are sent to the computer 12 which then instructs the transmitter 10 to send pulses to the coil 15 that irradiates the scan item 14 at a range of frequencies which lie close the frequency calculated from some combination of one or more of the pixellated temperatures measured.

Again temperatures are converted to frequencies via equations, such as equation 1, for each separate substance. Pulses at these frequencies excite the NQR substance within the item create a small RF magnetic field that induces a small voltage on the coil 15 which is measured by the receiver 11 and sent to the computer 12, resulting in a detection.

In this embodiment it may be found that the best temperature to scan the object is some mathematical combination of one or more of the pixellated temperatures measured. This embodiment also allows the computer to check that the scanned object is not excessively hot or excessively cold. If it is found to have a

substantially different temperature to the other surroundings the item is flagged to be checked manually by the operator.

The seventh embodiment of the best mode is substantially identical to the preceding embodiment, except that in the seventh embodiment, a temperature sensor or sensors 13 and temperature probe or probes 13 are attached to the NQR scanner creating one or more thermal images and temperature probe measurements of the surroundings. Signals representative of these images and temperature probe measurements are sent to the computer 12 which then instructs the transmitter 10 to send pulses to the coil that irradiates the scan item 14 at a range of frequencies which lie close to the frequency that is calculated from some mathematical combination of one or more of the pixellated temperatures and temperature probe measurements.

As before, temperatures are converted to frequencies via equations such as equation 1 for each separate substance. Pulses at these frequencies excite the NQR substance within the item creating a small RF magnetic field that induces a small voltage on the coil 15 which is measured by the receiver 11 and sent to the computer 12, resulting in a detection.

In this embodiment it may be found that the best temperature to scan the item is some mathematical combination of one or more of the pixellated temperatures and the environmental surroundings. The embodiment also allows the computer to check that bag is not excessively hot or excessively cold. If found to have a substantially different temperature to the other surroundings the item is flagged to be checked manually by the operator.

The eighth embodiment of the best mode is substantially identical to the preceding embodiments, except that in the eighth embodiment, one or more temperature 'tags' 20 are attached to the item 14 to be scanned. The tags 20 are small units and either display the temperature of the item to which they are attached, or the 'tag' emits an RF signal which is received by an aerial attached to the computer 12 to inform it of the item's temperature.

Signals representative of the displayed temperature by way of the emitted RF signal are input into the computer 12, and the computer then instructs the transmitter to send pulses to the coil 15 that irradiates the scan item 14 at a range of frequencies which lie close to the frequency calculated from some mathematical combination of one or more of the temperatures indicated by the tag or tags.

As before, temperatures are converted to frequencies via equations such as equation 1 for each separate substance. Pulses at these frequencies excite the NQR substance within the item setting a small RF magnetic field that induces a small voltage on the coil 15 which is measured by the receiver 11 and sent to the computer 12, resulting in a detection.

In this embodiment it may be found that the best temperature to scan the bag is some mathematical combination of one or more of the temperatures indicated by the tags.

It should be appreciated that the scope of the invention is not limited to any particular one embodiment described herein, and that different combinations of features and modifications to the scanner device in order to accommodate the same that do not depart from the spirit of the invention fall within its scope.

Dated this 24th day of June 2002.

Thorlock International Limited

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Perth, Western Australia
Patent Attorneys for the Applicant(s)

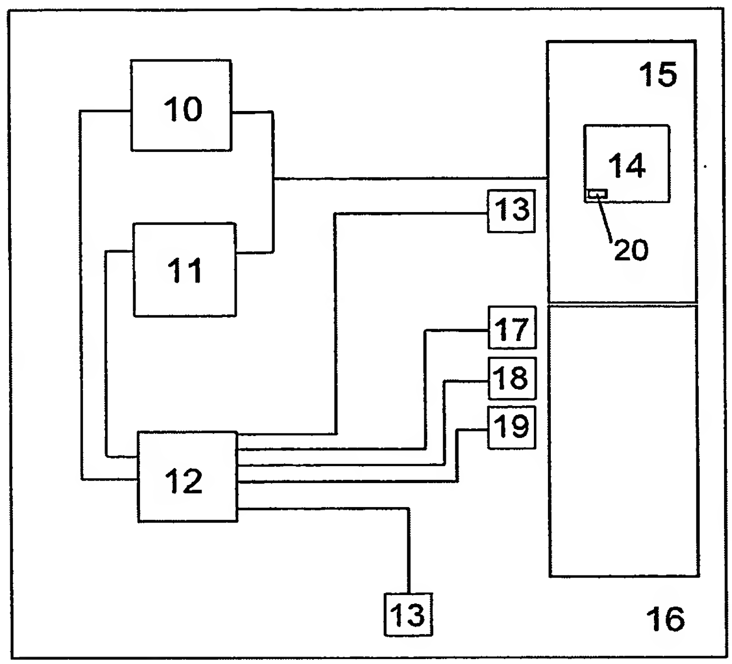

Fig.1

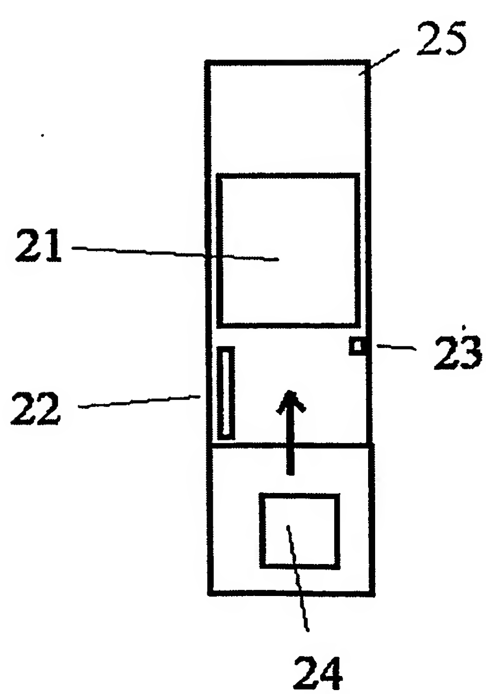

Fig.2

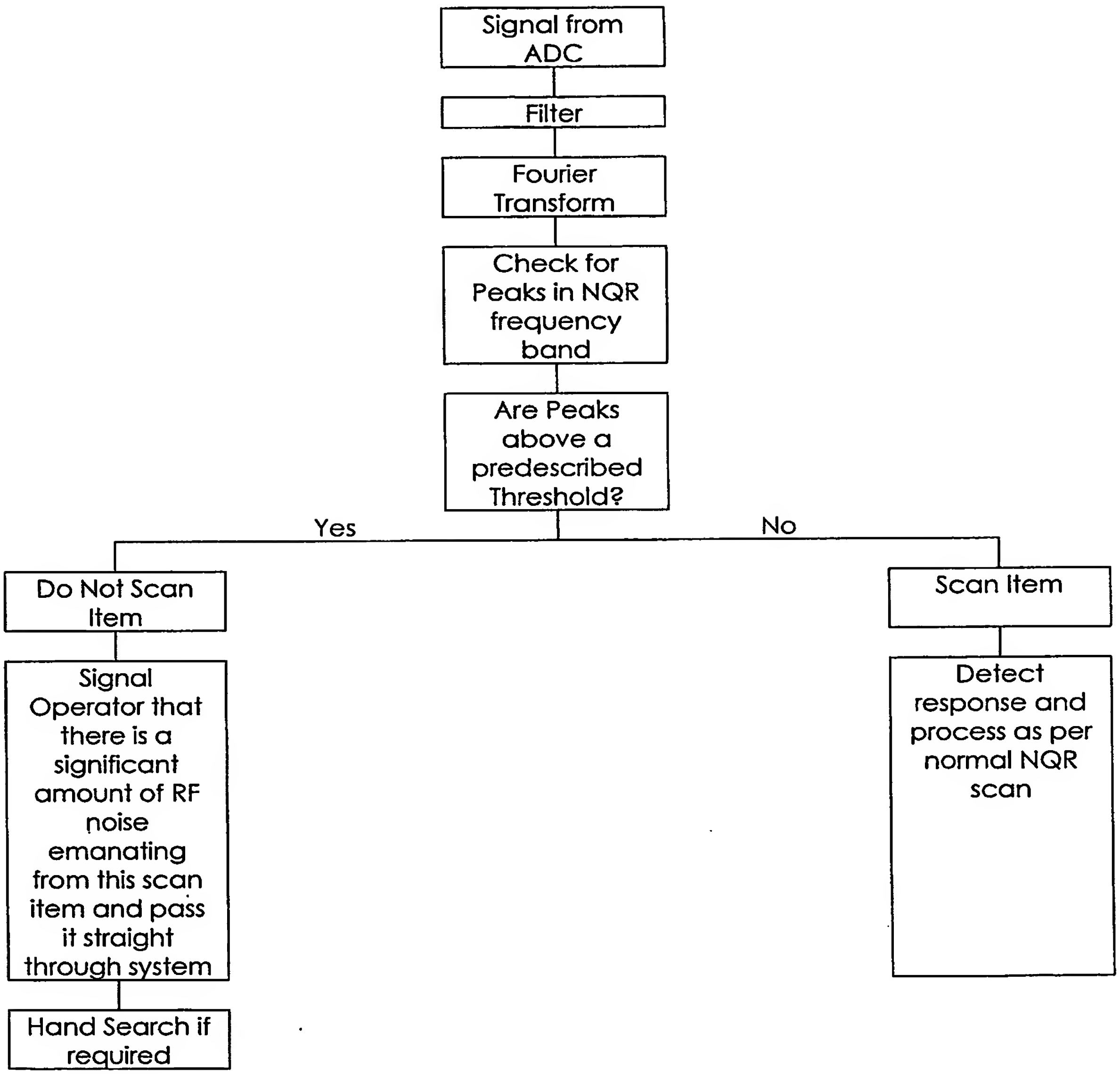
Signal from ADC
Filter
Fourier Transform
Check for Peaks in NQR frequency band
Are Peaks above a predescribed Threshold?
Yes
No
Do Not Scan Item
Signal Operator that there is a significant amount of RF noise emanating from this scan item and pass it straight through system
Hand Search if required
Scan Item
Detect response and process as per normal NQR scan

Fig. 3

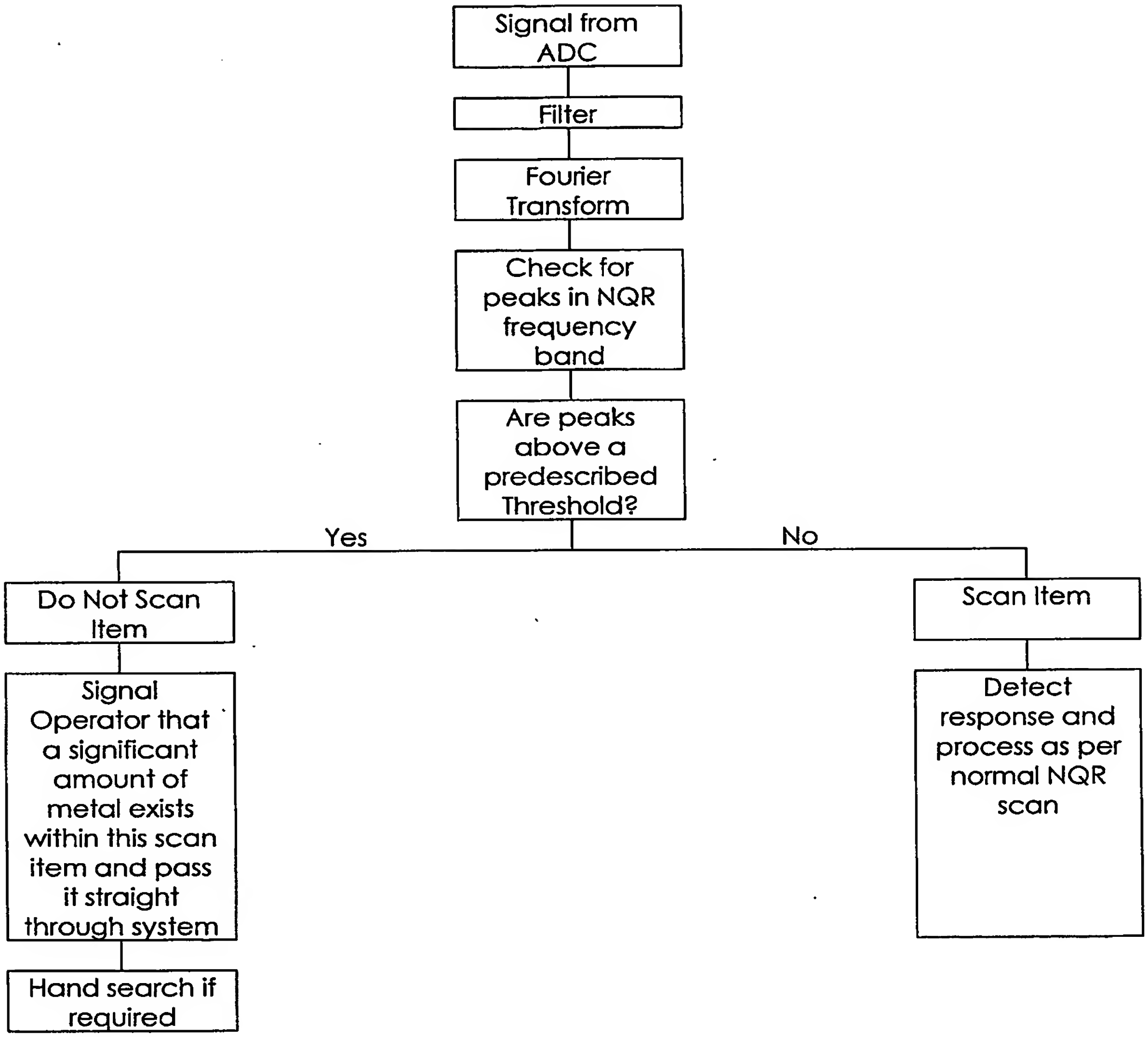
Signal from ADC
Filter
Fourier Transform
Check for peaks in NQR frequency band
Are peaks above a predescribed Threshold?
Yes
No
Do Not Scan Item
Signal Operator that a significant amount of metal exists within this scan item and pass it straight through system
Hand search if required
Scan Item
Detect response and process as per normal NQR scan

Fig. 4

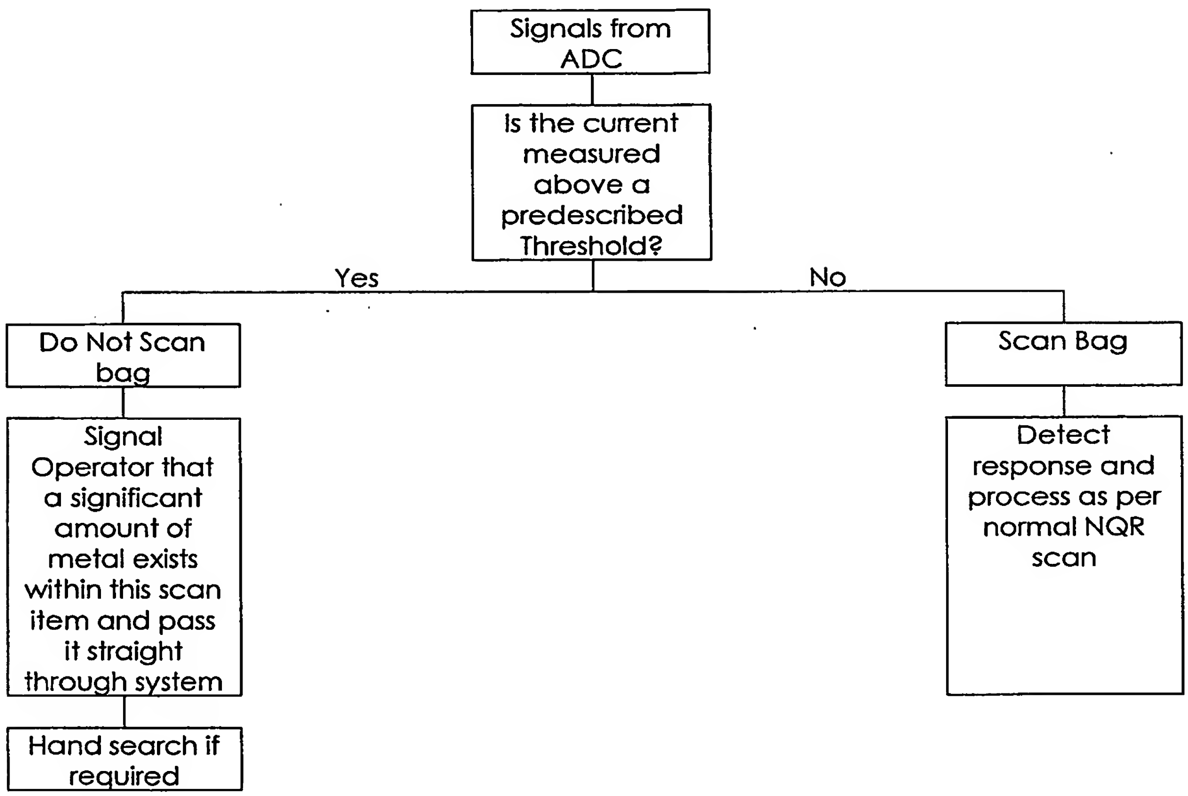
Signals from ADC
Is the current measured above a predescribed Threshold?
Yes
No
Do Not Scan bag
Signal Operator that a significant amount of metal exists within this scan item and pass it straight through system
Hand search if required
Scan Bag
Detect response and process as per normal NQR scan

Fig. 5

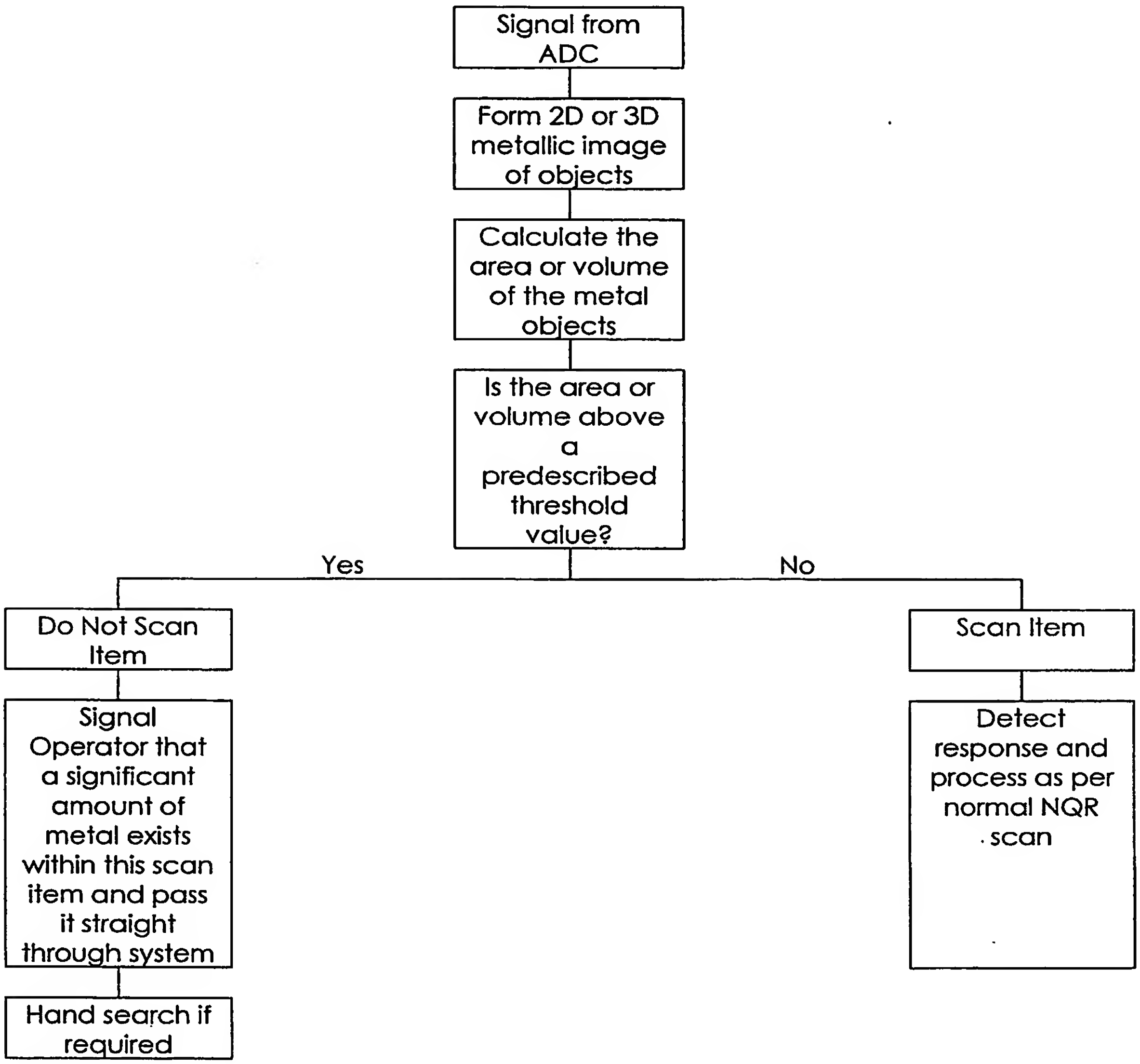
Signal from ADC
Form 2D or 3D metallic image of objects
Calculate the area or volume of the metal objects
Is the area or volume above a predescribed threshold value?
Yes
No
Do Not Scan Item
Signal Operator that a significant amount of metal exists within this scan item and pass it straight through system
Hand search if required
Scan Item
Detect response and process as per normal NQR scan

Fig. 6

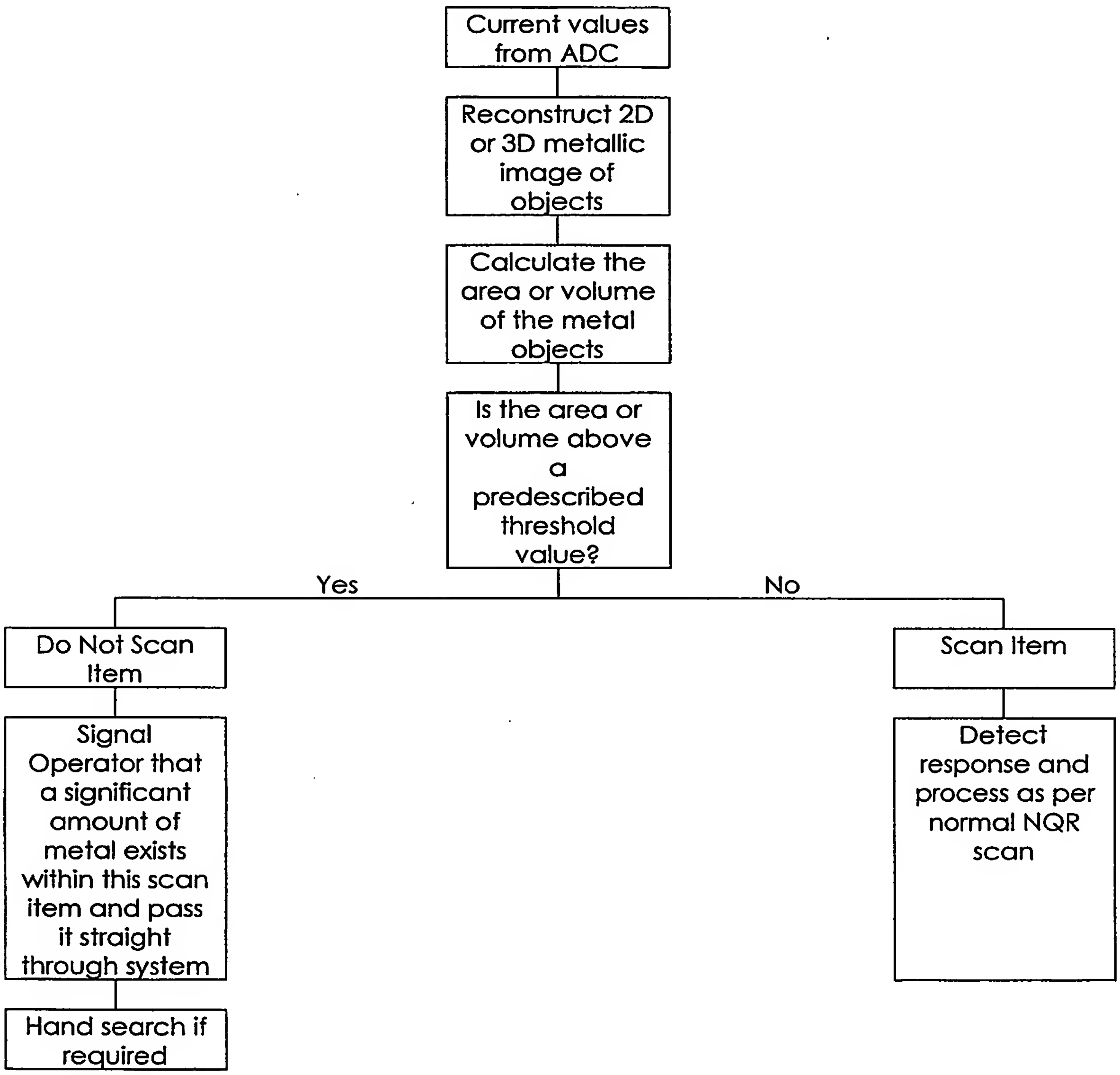
Current values from ADC
Reconstruct 2D or 3D metallic image of objects
Calculate the area or volume of the metal objects
Is the area or volume above a predescribed threshold value?
Yes
No
Do Not Scan Item
Signal Operator that a significant amount of metal exists within this scan item and pass it straight through system
Hand search if required
Scan Item
Detect response and process as per normal NQR scan

Fig. 7